Distribution, Habitat, and Relative Abundance of Cactus Ferruginous Pygmy-Owls in Sonora, Mexico

2000 Annual Report

Submitted to:

Frank M. Baucom
United States Department of the Interior
Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Submitted by:

Aaron D. Flesch, Graduate Research Assistant
Robert J. Steidl, Assistant Professor
University of Arizona
School of Renewable Natural Resources
325 Biological Sciences East
Tucson, Arizona 85721

December 2000

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INTRODUCTION

Cactus ferruginous pygmy-owls (*Glaucidium brasilianum cactorum*) are the northernmost of four subspecies of ferruginous pygmy-owls (van Rossem 1937, Johnsgard 1988, USFWS 1997). Although once locally common in lowland central and southern Arizona (Bendire 1888, Fisher 1893, Breninger 1898, Gilman 1909), the owls have been extirpated throughout much of their former U.S. range (USFWS 1997). As a result, the USFWS listed the Arizona population of cactus ferruginous pygmy-owls (herein pygmy-owl) as endangered in 1997 and decided to continue reviewing status in Mexico (USFWS 1997). At the time of listing, fewer than 20 pygmy-owls were known to occur in Arizona.

Although historical records exist from throughout Sonora, recent information indicates that pygmy-owls are absent, rare, and/or uncommon in northern Sonora (Hunter 1988, USFWS 1997, Russell and Monson 1998). Since 1925, there are 5 or fewer known records of pygmy-owls north of 30° N. latitude (van Rossem 1945, Terrill et al. 1981, Hunter 1988, S. Russell, personal communication, R. Duncan, personal communication). Pygmy-owls are common locally in southern Sonora in and at the edge of tropical deciduous forest but less common in tropical thornscrub of the coastal plain (Russell and Monson 1998, Cartron et al. 2000). The only confirmed nesting records in Sonora are from the extreme southeast near Güiricoba (Russell and Monson 1998).

Concerns about possible declines of pygmy-owls in Sonora exist because of habitat loss and fragmentation due to conversion of desertscrub and thornscrub to exotic buffelgrass (*Pennisetum ciliare*) pastures, urban and agricultural development, and/or fuel-wood cutting (Hunter 1988, USFWS 1997). Currently, over half of Sonora's fuel-wood comes from northern districts where mesquite and ironwood forests have disappeared at alarming rates (Búrquez and Martínez-Yrizar 1997, Suzán et al. 1997).

Despite observations indicating that pygmy-owls are uncommon and perhaps migratory in northern Sonora (Russell and Monson 1998), no quantitative information exists about their abundance and distribution in Sonora. Our efforts will facilitate the USFWS's ongoing review of status in Mexico, aid development of recovery strategies in the U.S., augment knowledge of pygmy-owl biology, and provide current information to Mexican natural resource agencies. This report is a summary of year 2000 efforts to meet the following objectives:

- Determine the distribution of pygmy-owls in Sonora.
- Describe habitat of pygmy-owls in Sonora.
- Compare sites where owls are present to those available
- Determine macrohabitat and landscape features related to presence and relative abundance.
- Estimate density or relative abundance across vegetation types and landscape formations.
- Evaluate current condition and threats to pygmy-owl habitat in Sonora.

METHODS

Study Area: During our first field season, with the aid of biologists from the University of Arizona and Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora (IMADES), we surveyed areas throughout the Mexican state of Sonora north of 27' 45" N. latitude. We concentrated efforts in northern Sonora to assess status in the border region, especially sites east and north of Mexico Route 2 and west of Mexico Route 15. Other focal areas included the coastal mountains and valleys north and east of Guaymas, the lower and middle Rio Bacoachi watershed on the westcentral coastal plain, foothills, plains, and valleys southeast of Hermosillo near La Colorada and Tecoripa, and areas west of Benjamin Hill. We also visited the following valleys in the mountains and foothills east of the coastal plain: the upper, middle, and lower Rio San Miguel Valley, the middle and upper Rio Sonora Valley from Mazocahui to Arizpe, and the Bavispe Valley in the Granados and Villa Hidalgo areas. The southernmost areas we visited were near Presa Alvaro Obregón 30 km north of Ciudad Obregón.

Sites selection: We stratified Sonora by both major vegetation type and topographic formation. We chose survey sites from areas below 1,200 m except those in the extreme northwest (Gran Desierto de Altar) and northeast (Chihuahuan Desert). As vegetation stratum, we considered the 4 subdivisions of the Sonoran Desert (Lower Colorado River Valley, Arizona Upland, Central Gulf Coast, and Plains of Sonora) and the 3 other major vegetation types (Semidesert/Sonoran Savannah Grassland, Sinaloan Thornscrub, and Sinaloan Deciduous Forest) found below 1,200 m in Sonora (Brown 1982). We then stratified each major vegetation type into 4 topographic formations (valley bottoms, flats-lower bajada, upper bajada, and mountains/canyons).

We generated random UTM coordinates and used Instituto Nacional de Estadistica Geografia e Informatica (INEGI) 1:250,000 and 1:50,000 topographic maps and Brown and Lowe's (1980) Biotic Communities map to assign points to vegetation and topographic types. We allocated effort according to size of strata. We located the closest accessible point (within 2 km of a motorized access point) along a significant wash (>2 m in width) in each topographic formation represented within 20 km. When constraints prevented surveys within all 4 topographic formations we selected the most accessible formations while attempting to balance sample allocation among all surveys. We also conducted broadcast surveys incidentally in what appeared to be suitable habitat while travelling between sites. These observations are considered separately from other surveys.

Owl survey techniques: We used recorded, conspecific territorial calls to elicit responses from pygmy-owls. We used similar survey periods, distance between stations, and calling/listening times as used in recent years in Arizona and Texas (Lesh and Corman 1995. Mays 1996. USFWS 2000). We surveyed during evening (2 hours before and 1 hour after sundown) and early morning (1 hour before and 3 hours after sunrise). At each station, we used alternating 30 to 45 second listening and playing sequences and allowed a listening/rest period during the first and last 30 to 45 seconds. At the first 25 transects, we remained at stations for 6 or 10 minutes to evaluate times to first detection. Of the 33 pygmy-owls detected average time to response was 3.0 minutes (SE = 0.34) and never greater than 6 minutes. To be conservative, we spent 8 minutes at stations during the remainder of surveys.

We placed stations in wash channels every 350 to 400 m. When an owl was detected, we located the next station 550 to 600 m from the previous to reduce the probability of detecting the same bird more than once. We stopped broadcasts following detection but remained at stations for several minutes afterwards. When owls were difficult to isolate aurally we often resumed broadcasts to stimulate movement. For each owl, we estimated distance to initial point of detection, compass direction, sex (based on vocalization), vegetation type (upland, riparian, or undetermined), the station closest to detection point, and whether initial detection was aural or visual. We used simultaneous detection, distance, and direction to differentiate among multiple owls and to estimate numbers. We also estimated wind speed (Beaufort scale), percent cloud cover, and temperature at the start and end of each transect. We did not survey during rain or when wind speed consistently exceeded approximately 20 kph.

Habitat sampling: We measured vegetation and environmental characteristics along survey transects at macrohabitat and landscape scales using rapid assessment techniques. Major vegetation types were classified using Brown and Lowe's (1980) biotic communities map. When mapped types did not conform to what was on the ground, we entitated types based on definitions and characteristics described in the literature and noted transitional areas between types (Gentry 1942, Shreve 1951, Wiseman 1980, Brown 1982, Martin et al. 1998, Búrquez et al. 1999, Robichaux and Yetman 2000). Topographic formations were defined as follows: valley bottoms were the lowest major primary drainages in a landscape, flats-lower bajadas included lowlands below or within the lower half of outwash plains, upper bajadas are in the upper half of a ranges' outwash plain and contact mountains at the upper end, and mountains were rocky upland areas with drainages often forming canyons.

At each station we measured canopy height, noted dominant plants and understory/shrubs, recorded presence of vegetation formations, and estimated vegetation volume. The dominant 2 or 3 woody or succulent canopy and understory plants were determined on the basis of both density and height (most common ranked by height). In some cases, when congeneric plants were similar in structure we pooled species by growth form (Appendix A). We listed vegetation formations (bosque, desertscrub, thornscrub, riparian scrub, gallery woodland, savannah, grassland, agriculture, and cienega) in order of cover at each station. We estimated average and maximum canopy height to the nearest meter and considered columnar cacti only when dominant. We estimated vegetation volume in 5 height strata (0-1 m, 1-3 m, 3-6 m, 6-12 m, and 12+m) to the nearest 10% when values were between 20 and 80% and to the nearest 5% otherwise. We measured vegetation in the riparian area and both sides of uplands at each station. We considered visible vegetation within 400 m of wash channels in all measurements.

Transition points between riparian and upland vegetation associations were noted along lines of structural and/or floristic contrast and the degree of contrast categorized as high, medium, low, and none. We used rangefinders to measured the width of the riparian vegetation association on both sides of washes. We recorded presence or absence of water, directional orientation, and the width of unvegetated wash channels at all stations by using a rangefinder and compass. With INEGI 1:50,000 topographic maps, we counted the number of washes within 1 km of transects and measured total elevational gradient perpendicular to the wash within 500 m of stations. We recorded distance to and species of nearest columnar cacti with cavity potential (>3 m tall and 20 cm diameter) at each station in 4, 90° quarters determined by a perpendicular line across washes. Similarly, we recorded trees with cavity potential (>6 m tall and 30 cm diameter) and measured their height. We ranked intensity (high, medium, or low) of land-use in 6 categories (grazing, mining, agriculture, wood-cutting, buffelgrass planting, and human structure) at all stations.

Analyses: All transects were mapped on INEGI 1:50,000 topographic maps and elevations and UTM coordinates at start and end stations recorded using maps and/or GPS. Along with numerous spatial layers provided by IMADES, we used these data to create distribution and abundance maps for pygmy-owls within Sonora. We used program Distance (version 3.5 release 5) to calculate density of male pygmy-owls within each stratum. Data analyses are in progress and thus far have been limited to descriptive statistics.

RESULTS

Owl surveys: Between February 12 and May 23, 2000 we surveyed 1,504 stations along 191 transects (572,680 m). Average transect length was 3003 m (SE = 56.6, range 1200 - 4800). Average number of stations per transect was 7.9 (SE = 0.12) and average distance between stations was 433.5 m (SE = 4.48). All but 4 surveys were conducted during mornings and average start and end times were 6:16 and 8:54 AM, respectively. Mean start and end temperatures were 54.5°F (SE = 0.66) and 73.9°F (SE = 0.61), respectively. Only 5 surveys were aborted due to wind and/or rain.

We detected a total of 240 pygmy-owls, 208 males and 32 females, and at least 1 on 45% of the 191 transects. Twenty-two additional detections were classified as possible or sex undetermined. Mean number of males and females per station was 0.14 and 0.02, respectively. Detections of females declined throughout the season with 0.05 per station before and 0.002 after March 24. All pygmy-owls except 1 (96.6%) were detected aurally. Location of initial detection was evenly divided among uplands (47%) and riparian (53%) for all detections classified. When pygmy-owls were present at stations they took an average of 2.6 minutes (SE = 0.14, range 0 - 12) to respond. Forty-one percent of pygmy-owls responded within the first minute while 95% responded within 6 minutes. Mean detection distance was 278 m (SE = 12.0, range 10 – 1000). Only 14% of pygmy-owls were detected beyond 400 m. We confirmed pair occupancy at 12 sites and obtained evidence of pair occupancy at another 5 sites. We found occupied cavities and assume nesting at 4 sites.

In addition to the 240 pygmy-owls detected during surveys, we documented 39 pygmy-owls incidentally. Eight incidental detections were females and 31 were males. Pair occupancy was confirmed at 3 sites and occupied nest cavities were located at 2 sites.

Distribution within Sonora: Pygmy-owls were distributed widely throughout Sonora from the international line south to Presa Obregón. Within approximately 150 km (90 mls) of the international border we documented 139 pygmy-owls (and 3 occupied nests), 26 of which were within 10 km (6 mls) of the border. Pygmy-owls were not found in interior valleys above the coastal plain in central Sonora (Rio Sonora, Rio Bavispe) except in the Rio San Miguel Valley. We did not detect pygmy-owls in the coastal mountains and valleys north and east of Guaymas (Figure 1).

Abundance and effort within strata: One hundred seventy-two of the 191 transects occurred in fairly discrete major vegetation areas and the remainder occurred in transitional types. Our effort (in meters of transects) was greatest in the Arizona Upland subdivision of the Sonora Desert and in Sinaloan Thornscrub and smallest in the Central Gulf Coast and Lower Colorado River Valley subdivisions. Effort within upper and lower bajadas and valley bottom topographic formations was approximately equal but lower within canyons/mountains due to limited accessibility. (Table 1).

We found the greatest number (0.26 per station) and highest frequency of occurrence (69% of transects) of pygmy-owls within the Arizona Upland subdivision in northern Sonora (Table 1). Densities were greatest in the Plains of Sonora (0.229 per 10,000 ha^2) and lowest in Sinaloan Thornscrub (0.070 per 10,000 ha^2). Sample sizes for the Central Gulf Coast were small and although density seems relatively high (0.205 per 10,000 ha^2) frequency of occurrence (14% of transects) was low.

Densities were generally greater on bajadas and lower in canyons and valley bottoms but trends varied across vegetation formations (Table 1). Pygmy-owls were never found in narrow canyons with steep slopes. Canyons that were occupied were wide (>200 m) and generally had flat bottoms and shallow slopes. Density in canyons is confounded by detections that occurred in the mouths of canyons at or near the interface with upper bajadas.

Figure 1: Distribution, adundance, and breeding status of ferruginous pygmy-owls in Sonora, Mexico based on year 2000 survey effort

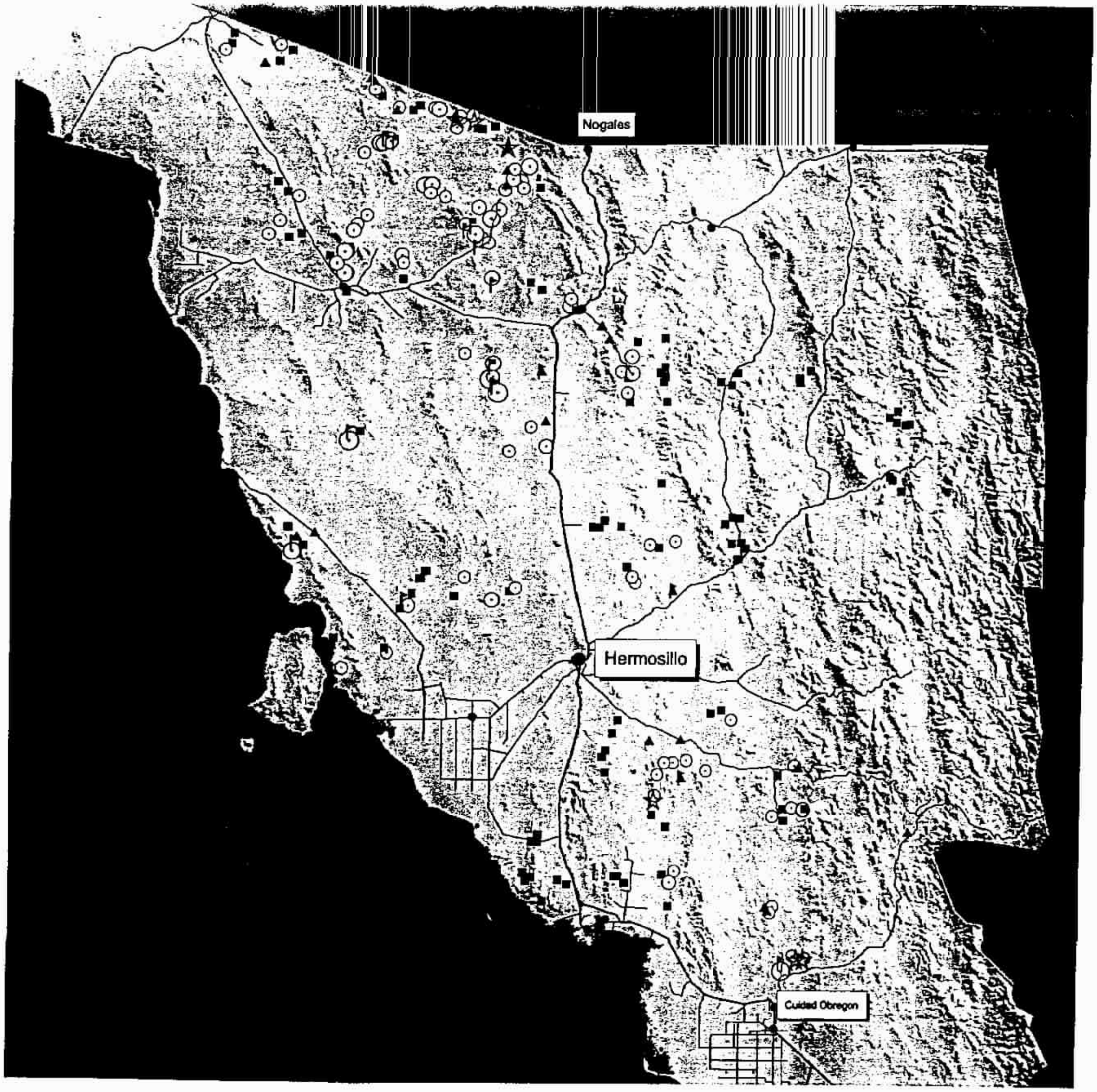
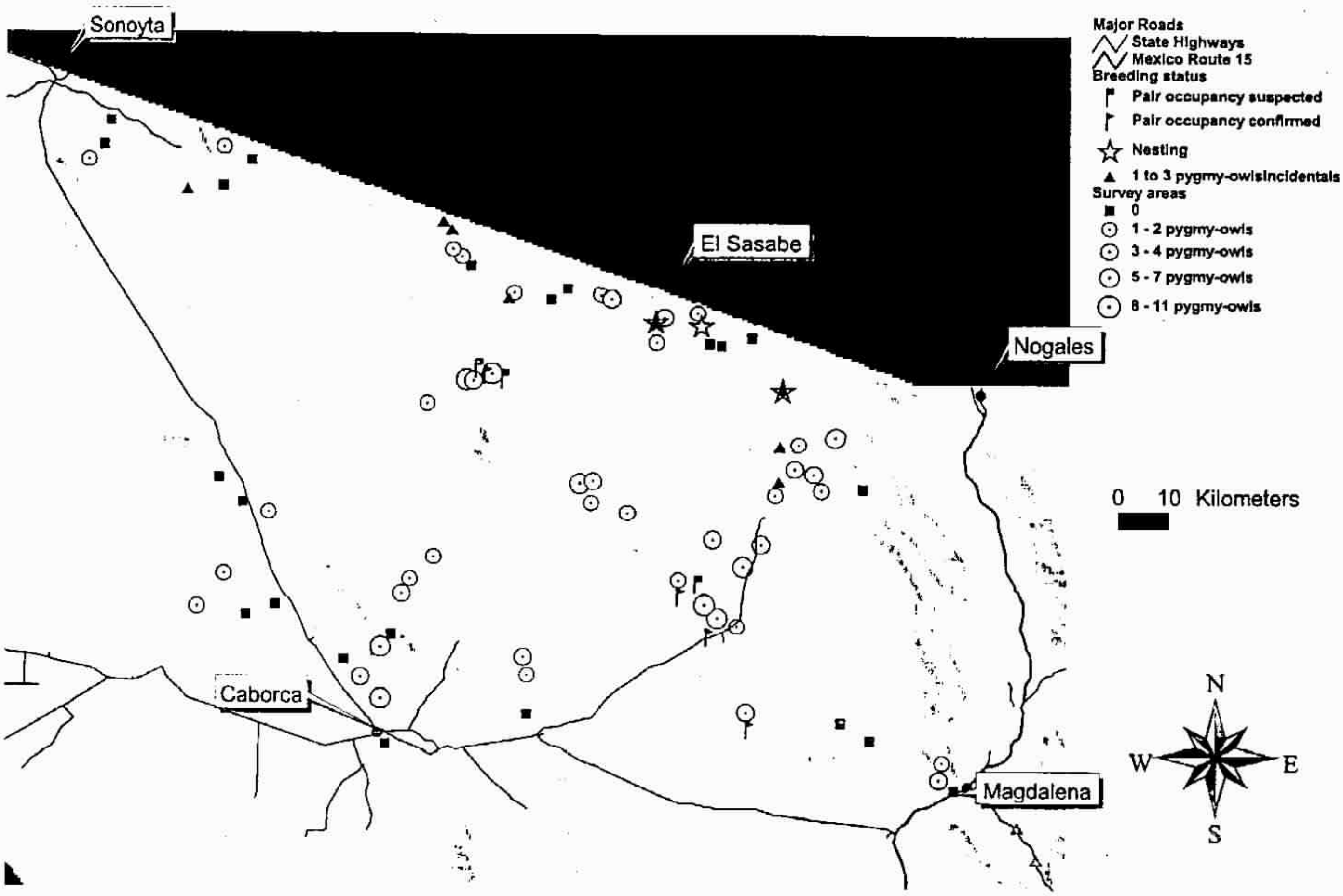


Table 1: Abundance and survey effort within major vegetation and topographic types of ferruginous pygmy-owls in Sonora, Mexico based on year 2000 field effort.

	transects	Effort (m)	Percent frequency of occurrence	No. male pygmy-owls within 800m	Density (#/10,000ha^2)	95% CI for Density
Arizona Upland	46	164,990	69%	79	0.184	0.114 - 0.297
valley bottoms	9	31,460	67%	24	0.203	0.096 - 0.431
lower bajada	14	49,530	86%	30	0.644	0.134 - 3.096
upper bajada	15	54,305	57%	21	0.141	0.067 - 0.296
canyon	8	29,695	50%	4	0.103	0.024 - 0.432
Central Gulf Coast	14	39,510	14%	7	0.205	0.051 - 0.834
valley bottoms	1	4,800	100%	6	1.400	0.341 - 5.753
lower bajada	4	8,790	0%	0	0.000	n/a
upper bajada	4	10,890	25%	1	1.827	0.185 - 18.028
canyon	5	15,030	0%	0	0.000	n/a
Plains of Sonora	31	92,820	42%	32	0.229	0.124 - 0.423
valley bottoms	10	28,520	50%	9	0.099	0.044 - 0.220
lower bajada	11	34,450	17%	3	0.050	0.009 - 0.294
upper bajada	9	25,300	50%	12	0.377	0.149 - 0.953
canyon	1	4,550	100%	8	1.137	0.366 - 3.533
Semidesert Grassland	32	90,750	50%	32	0.165	0.090 - 0.301
valley bottoms	10	30,450	30%	4	0.192	0.038 - 0.974
lower bajada	8	22,000	50%	8	0.072	0.025 - 0.213
upper bajada	9	25,900	56%	15	0.428	0.170 - 1.080
canyon	5	12,400	67%	5	0.258	0.068 - 0.980
Sinaloan Thornscrub	50	137,940	30%	27	0.070	0.032 - 0.151
valley bottoms	15	40,870	18%	10	0.097	0.023 - 0.404
lower bajada	12	33,200	25%	6	0.138	0.035 - 0.550
upper bajada	8	20,750	60%	5	1.225	0.001 - 33.184
canyon	15	43,120	20%	4	0.048	0.011 - 0.210
Sinaloan Deciduous Forest	n/a	n/a	n/a	n/a	n/a	n/a
Lower Colorado River Valley	2	4,380	0%	0	0.000	0.000
All Transects Combined*	191	[illegible]	46%	205	0.172	0.134 - 0.221

Figure 2: Distribution and abundance of ferruginous pygmy-owls in the border region of Sonora, Mexico



Habitat: Although we have not yet analyized habitat data in detail, pygmy-owls occupied a wide range of vegetation associations and structural types. In Arizona Uplands, common dominant plant species included mesquite (see Appendix A for scientific names), paloverdes, acacias, ironwood, and saguaro. Most semidesert grassland sites had mesquite woodlands along washes with variable upland structure ranging from open savannah to shrub invaded thornscrub. Occupied sites in Sinaloan Thornscrub often had lower vegetation volume and bosque associated with ephemeral washes. In general, occupied sites across Sonora had fairly open canopy structure, intermediate to low vegetation volume, and average canopy heights that ranged from 2 to 20+ m.

We observed several notable patterns at occupied sites. Columnar cacti with cavity potential (saguaros, cardón, hecho, and organ pipe) were found at all occupied transects except 1. When columnar cacti were rare along occupied transects, pygmy-owls were often detected only where columnar cacti were found. In contrast, no obvious patterns were found between pygmy-owl occupancy and density of trees with cavity potential. Only 7 of 23 transects with surface water were occupied by pygmy-owls. Although we surveyed numerous transects dominated by cottonwood, willow, and/or ash, we found pygmy-owls within this vegetation association at only 1 site (Rio Yaqui). Pygmy-owls were detected from this vegetation association at a few transects, but in these cases owls called from upland desertscrub and often did not approach observers. Pygmy-owls were rarely detected in the mountains and valleys east of the coastal plain with most occupied sites in areas with low to moderate slope.

DISCUSSION

Pygmy-owls responded to broadcast calls fairly rapidly and from distances up to 1 km. Although males responded to broadcasts throughout the survey season, females were rarely detected after the middle of March, which corresponds to the period of nest selection, first copulation, and/or egg laying (Bent 1938, Flesch 1999, Proudfoot and Johnson 2000). Although most historical accounts of pygmy-owls from Arizona were in and around broadleaf riparian vegetation in major valley bottoms (Bendire 1888, Fisher 1893, Breninger 1898, Gilman 1909, Swarth 1914), this was not the pattern we found in Sonora. Throughout the range of *G. brasilianum* and *G. ridgwayi*, occupied sites have generally been associated with lowlands rather than montane forests or foothills (Howell and Robbins 1995, König et. al 1999). Occupied pygmy-owl sites in Sonora often followed this pattern and generally occurred on bajadas and in lowlands with shallow slope.

Pygmy-owls were distributed widely throughout the coastal plain of much of Sonora. Within Sonora, pygmy-owls ranged from common to rare in different landscapes. Despite few recent records from northern Sonora, we found pygmy owls throughout much of the border region from Sonoyta east to the Saric area. We also extended the breeding range of pygmy-owls from extreme southeast Sonora to within 4 km of the international line. Although results are preliminary, we found higher densities of pygmy-owls in desertscrub types in the north than Sinaloan Thornscrub of the south. Density of pygmy-owls is likely higher in southern and eastern Sinaloan Thornscrub where columnar cacti are more common and vegetation structure better developed. Our preliminary findings offer auspicious prospects for movement into and recovery of pygmy-owls in southern Arizona.

YEAR 2001 FIELD SEASON

During the upcoming field season we will continue pygmy-owl and habitat surveys using the methodology described above. We will concentrate efforts in the following areas not covered last season: tropical thornscrub and forests in southern Sonora, the middle Rio Yaqui Valley from above Presa Obregón to Divisadero, coastal Sonora from Puerto Libertad to the Rio Asuncion Delta, central Sonora in the upper Rio Bacoachi Valley, and the northwest between Caborca and Sonoyta. To distinguish between the similar sounding Colima pygmy-owl (*G. palmarum*) while in southern Sonora, we plan on visually confirming a sample of detections when in habitat suitable for both species. Next season, surveys will be conducted between January 8 and May 28, 2001.

We also plan to focus in the border region. We will re-survey a random sample of transects surveyed in year 2000 to access variation in response rates between years. We will also survey a random sample of new transects 2 or more times to assess intra-year variation in response rates. Re-surveys will be done in conjunction with nest searches. If funding allows, we will sample vegetation and physical characteristics at nest sites and random available sites to describe nests and determine features selected by pygmy-owls.

ACKNOWLEDGEMENTS

We thank Frank Baucom and Mike Wrigley of the AZESFO for their continued interest in this program. Without their support, our work would not be possible. We also thank Eduardo Lopez, Andres Villarreal, and Gabriel Valencia of IMADES for logistical and field support while in Sonora. Robert Hunt, Alexis Bachrach, and Sky Jacobs provided invaluable assistance in the field and are commended for their efforts. University of Arizona professors Bill Mannan and Bill Shaw evaluated and contributed to the design of this study.

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APPENDIX A: Common, scientific, and family names, functional groups, and codes for dominant plant species.

Code	common name	scientific name	Family
ABUT	indian mallow	*Abutilon sp*	Malvaceae
ACAN	whiteball acacia	*Acacia angustissima*	Leguminosae
ACCOA	boat-thorn acacia	*Acacia cochliacantha*	Leguminosae
ACCO	white-thorn acacia	*Acacia constricta* & *A. neovernicosa*	Leguminosae
ACCOU		*Acacia coulteri*	Leguminosae
ACFA	sweet acacia	*Acacia farnesiana*	Leguminosae
ACGR	catclaw acacia	*Acacia greggii* & *A. occidentalis*	Leguminosae
ACPE	feather acacia	*Acacia pennatula*	Leguminosae
ACPR	guamuchilillo	*Acacia pringlei*	Leguminosae
ACAC	acacia species	*Acacia sp*	Leguminosae
ACWI	palo blanco	*Acacia willardiana*	Leguminosae
AGAV	agave	*Agave sp.*	Agavaceae
ALSI	palo joso	*Albezzia sinaloensis*	Leguminosae
BURS	torote	All *Bursera* expect BUHI	Burseraceae
FORB	forbs	all forbs	
GRAS	grass	All grass except bufflegrass	Gramineae
ALOY	bee brush	*Aloysia sp*	Verbenaceae
AMAM	canyon ragweed	*Ambrosia ambrosiodes*	Compositae
AmDe	triangle leaf bursage	*Ambrosia deltoidia*	Compositae
AMDU	white bursage	*Ambrosia dumosa*	Compositae
AMFR	false indigo bush	*Amorpha fruticosa*	Leguminosae
ANTH	desert honeysuckle	*Anisacanthus thurberi*	Acanthaceae
ATPO	desert saltbrush	*Atriplex polycarpa*	Chenopodiaceae
ATRI	saltbrush	*Atriplex sp*	Chenopodiaceae
BAGL	seepwiilow	*Baccharis glutinosa*	Compositae
BASO	desert broom	*Baccharis sarothroides*	Compositae
BEJU	bebbia	*Bebbia juncea*	Compositae
BEHE	algarita	*Berberis haematocarpa*	Berberidaceae
BRIC	brickell bush	*Brickellia sp*	Compositae
BUHI	copal	*Bursera hindsiana*	Burseraceae
CAPA	piojo	*Caesalpinia palmeri*	Leguminosae
CAPUL	bird-of-paradise	*Caesalpinia pulcherrima*	Leguminosae
CAPU		*Caesalpinia pumila*	Leguminosae
CAGI	saguaro	*Carnegiea gigantea*	Cactaceae
CEAC	kapok, pochote	*Ceiba acuminata*	Bombaceae
CEPA	desert hackberry	*Celtis pallida*	Ulmaceae
CERE	netleaf hackberry	*Celtis reticulata*	Ulmaceae
CERC	blue, foothill or Sonoran paloverde	*Cercidium sp*	Leguminosae
CCAC	columnar cacti	*Cerus, Lophocerus, Carnegiea, Pachycerus*	Cactaceae
CHLI	desert willow	*Chilopsis linearis*	Bignoniaceae
COVI	palo colorado	*Colubrina viridis*	Rhamnaceae
COND	crucillo	*Condalia sp*	Rhamnaceae
COWA	crucillo	*Condalia warnockii*	Rhamnaceae
COPA	vara prieta	*Cordia parvifolia*	Boraginaceae
COSO	palo de asta	*Cordia sonorea*	Boraginaceae
COGL	coursetia, samota	*Coursetia glandulosa*	Leguminosae
CRSO	Sonora croton	*Croton sonorea*	Euphorbiaceae
DOVI	hopbush	*Dodonaea viscosa*	Sapindaceae
ENFA	white brittlebush	*Encelia farinosa*	Compositae
ENFR	green brittlebush	*Encelia frutescens*	Compositae
EUPH	euphorbia	*Euphorbia sp*	Euphorbiaceae
ESPO	kidneywood	*Eysenhardtia polystachya*	Leguminosae
FAPA	Apache plume	*Fallugia paradoxa*	Rosaceae
FICU	Fig	*Ficus sp*	Moraceae
FOWA	jito	*Forchammeria watsoni*	Capparaceae

FORE	desert olive	*Forestiera sp*	Oleaceae
FOMA	tree ocotillo	*Fouquieria macdougalii & diguetii*	Fouquieriaceae
FOSP	ocotillo	*Fouquieria splendens*	Fouquieriaceae
FRAN	saladito	*Frankenia sp*	Frankeniaceae
FRVE	ash	*Fraxinus velutina*	Oleaceae
GUCO	guayacan	*Guaiacum coulteri*	Zygophyllaceae
GUUL	guacima	*Guazuma ulmifolia*	Sterculiaceae
GUSO	snakeweed	*Gutierrezia sorathrea*	Compositae
HEBR	palo de brasil	*Haematoxylon brasiletto*	Leguminosae
HILA	copalquin	*Hintonia latiflora*	Rubiaceae
HYMO	burrobush	*Hymenoclea monogyra*	Compositae
HYEM	desert lavender	*Hyptis emoryi*	Labiatae
HYPA	desert lavender	*Hyptis palmeri*	Labiatae
IPAR	tree morning glory, palo santo	*Ipomoea arborescens*	Convolvulaceae
ISTE	burroweed	*Isocoma tenuisecta*	Compositae
JATR	jatropha	*J. cardiophylla, cinerea, & cuneata*	Euphorbiaceae
JAPU	San Juanito	*Jacquinia pungens*	Theophrastaceae
JACO	torota blanca	*Jatropha cordata*	Euphorbiaceae
JUGL	walnut	*Juglans sp*	Juglandaceae
JUNI	juniper	*Juniperus sp*	Cupressaceae
KOSP	all-thorn	*Koeberlinia spinosa*	Capparaceae
LATR	creosote	*Larrea tridentata*	Zygophyllaceae
LOSH	senita	*Lophocerus shottii*	Cactaceae
LYCI	lycium	*Lycium* sp or *Phalothamnus sp*	Solanaceae or Phytolaccaceae
LYMI	lysiloma	*Lysiloma microphyllum*	Leguminosae
LYWA	tepeguaje	*Lysiloma watsoni*	Leguminosae
METO	malva rosa	*Melochia tomentosa*	Sterculiaceae
MIBI	wait-a-minute bush	*Mimosa biuncifera*	Leguminosae
MIDY	velvet pod mimosa	*Mimosa dysocarpa*	Leguminosae
MILA	garabatillo	*Mimosa laxiflora*	Leguminosae
OLTE	ironwood, palo fiero	*Olneya tesota*	Leguminosae
OPUN	prickly pear or cholla	*Opuntia sp*	Cactaceae
PAPE	hecho	*Pachycereus pecten-arboriginum*	Cactaceae
PAPR	cardon	*Pachycereus pringlei*	Cactaceae
PAAC	Mexican paloverde	*Parkinsonia aculeata*	Leguminosae
BUFF	bufflegrass	*Pennisetum ciliare*	Gramineae
PIMO	palo blanco	*Piscidia mollis*	Leguminosae
PICO	ejoton	*Pithecellobium confine*	Leguminosae
PIDU	guamuchil	*Pithecellobium dulce*	Leguminosae
PIME	chino	*Pithecellobium mexicanum*	Leguminosae
PISO	palo gato	*Pithecellobium sonorae*	Leguminosae
PLAN	sycamore	*Plantanus sp.*	Plantanaceae
POFR	Fremont cottonwood, alamo	*Populus fremontii*	Salicaceae
PODI	Mexican cottonwood, alamo	*Populus mexicana var dimorpha*	Salicaceae
PROS	mesquite	*Prosopis sp.*	Leguminosae
QUER	oak	*Quercus sp*	Fagaceae
RAEC	papache	*Randia echinocarpa*	Rubiaceae
RAOB	papachillo	*Randia obocarpa*	Rubiaceae
RATH	papache gris	*Randia thurberi*	Rubiaceae
RICO	castor bean	*Ricinus communis*	Euphorbiaceae
RUEL	rama parda	*Ruellia sp*	Acanthaceae
SALI	willow, sauce	*Salix sp*	Salicaceae
SAMB	elderberry	*Sambucus sp*	Caprifoliaceae
SASA	western soapberry	*Sapindus saponaria*	Sapindaceae
SABI	Mexican jumping bean	*Sapium biloculare*	Euphorbiaceae
SENE	senecio	*Senecio sp*	Compositae
SIOC	bebelama	*Sideroxylon occidentale*	Sapotaceae
SICH	jojoba	*Simmondsia chinensis*	Simmondsiaceae
STEG	amole	*Stegnosperma halimifolium/watsonii*	Stegnospermataceae

STTH	organ pipe, pitahaya	*Stenocerus thurberi*	Cactaceae
TAMA	tamarisk	*Tamarisk sp*	Tamaricaceae
TRCA	trixis	*Trixis californica*	Compositae
VAGL	cacarahue	*Vallesia glabra*	Apocynaceae
VIMO	uvalama	*Vitex mollis*	Verbenaceae
YUCC	Yucca	*Yucca sp*	Liliaceae
XANT	cocklebur	*Zanthium sp.*	Compositae
ZASO	zanthoxylum	*Zanthoxylum sonorense*	Rutaceae
ZIAM	amole dulce	*Zizuphys amole*	Rhamnaceae
ZIOB	graythorn, espina gris	*Zizuphys obtusifolia*	Rhamnaceae
CIEN	wetland plants		
AG	agriculture		